DISCOVERY OF A NEW CASSINI-SIZE BASIN ON MARS FROM MOLA TOPOGRAPHIC DATA. H. Frey[1], S. Sakimoto[2], and J. Roark[3], [1]Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, frey@denali.gsfc.nasa.gov, [2]USRA at the Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, sakimoto@denali.gsfc.nasa.gov, [3]Science Systems & Applications, Inc., Lanham, MD 20706, roark@denali.gsfc.naasa.gov.

Summary: MOLA profile data collected during the Science Phasing Operations have revealed a previously unknown, 450 km wide, 2 km deep basin on Mars centered at 30N, 312W near the Phison Rupes. This structure, as large as and somewhat deeper than the very obvious Cassini impact basin located 1000 km to the SW, is not apparent in the existing good quality Viking imagery. Gridded MOLA data show the basin as a closed depression, but elevation contours show only weak correlation with what little structure exists in the area and with mapped geologic units. From analysis of slope breaks readily visible in two MOLA profiles we suggest this is at least a three-ring basin. Portions of rings from concentric fits to slope breaks align with some of the linear ridge-like structures of the Phison Rupes, and outline a region of lower crater density and smoother inter-crater plains. The discovery of such a pronounced topographic depression which lacks obvious visible structure suggests more such previously unknown features may exist on Mars, and that MOLA data may be useful in finding them.

There have been numerous searches for impact basins on Mars [1,2,3,4,5,6,7,8] based on Viking imagery and photogeologic mapping that sometimes delineates concentric arrangements of structures and units that may outline a probable basin. Here we present evidence for a previously unknown but large and deep basin whose existence is clearly revealed by MOLA profile and gridded data, but which has little or no expression in either Viking imagery or Viking-era topography. This basin is as large (~450 km diameter) and deeper (2 km) than the multi-ring Cassini impact basin or the Antoniadi impact feature, both of which occur in roughly the same eastern Arabia Terra part of Mars and which are both readily apparent in image data.

Figure 1 shows 7 MOLA elevation vs latitude profiles over an MDIM centered on the Phison Rupes region of Mars. N to S the profiles traverse smooth lowland plains, cross the crustal dichotomy boundary zone where elevation increases by several km [9], and continue across cratered uplands. Passes 264 and 245 show a pronounced 2 km depression at about 30N. This signficiant topographic low is not seen in pass 226 or 32, which lie about as far from 245 as does 264. Thus the depression appears to be a discrete and closed feature (see Figure 2), which we informally refer to as the "MOLA Hole". Topographic profiles derived from older USGS data along these same MOLA pass tracks do not show this Hole. It is not obvious in the MDIM, at least by comparison with the Cassini or Antoniadi impact structures, which are of comparable size (based on the width of the basin in the MOLA profiles). The area of the MOLA Hole does have a slightly lower density of impact craters and somewhat smoother intercrater plains, but no Cassini or Antoniadi rim like structure is obvious.

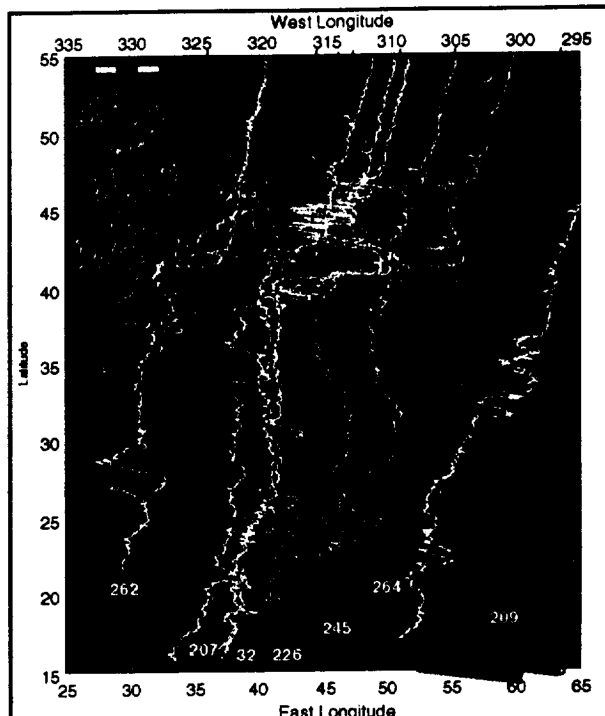

Figure 1. MOLA elevation versus latitude profiles over MDIM image. Black lines show the relocated MOLA tracks in the image coordinate system. Elevation profiles all at the scale shown for pass 209. Large basins (D~400 km) Cassini and Antoniadi indicated.

Despite its lack of expression in Viking imagery, the MOLA Hole is easily seen even in new contoured elevation data. Figure 2 shows topography both the USGS DEM (top) and from gridded data (bottom) that combines MOLA data with a low resolution spherical harmonic representation of occultation-derived heights [10]. The slight E-W elongation of the MOLA Hole topography is due to the relatively large separation between passes (Figure 1), but the apparent circular nature of the basin is very obvious. There is no hint of this basin in the USGS DEM.

In detailed views of both MOLA passes 245 and 264 (Figure 3) there are obvious and apparently matched slope breaks on either side of the basin. We used these and the assumption of circular symmetry to estimate the basin center and (topographic) ring diameters from concentric fits to the slope breaks. We previously showed for the Isidis Basin that such an approach produced a basin center and inner ring diameter from MOLA profile data that was indistinguishable from that derived from photogeologic mapping [11, 12]. For the MOLA Hole we infer a center near 30N, 312W and (at least) three concentric (topographic) rings, with diameters roughly 325, 450 and 670 km. Figure 2 shows these rings on the MDIM. Some of the ridges of the Phison Rupes appear to coincide with some portions of some of the rings, but ridges also cross between rings. There does appear to be a lower density of impact craters and a smoother inter-crater texture inside compared with outside the basin.

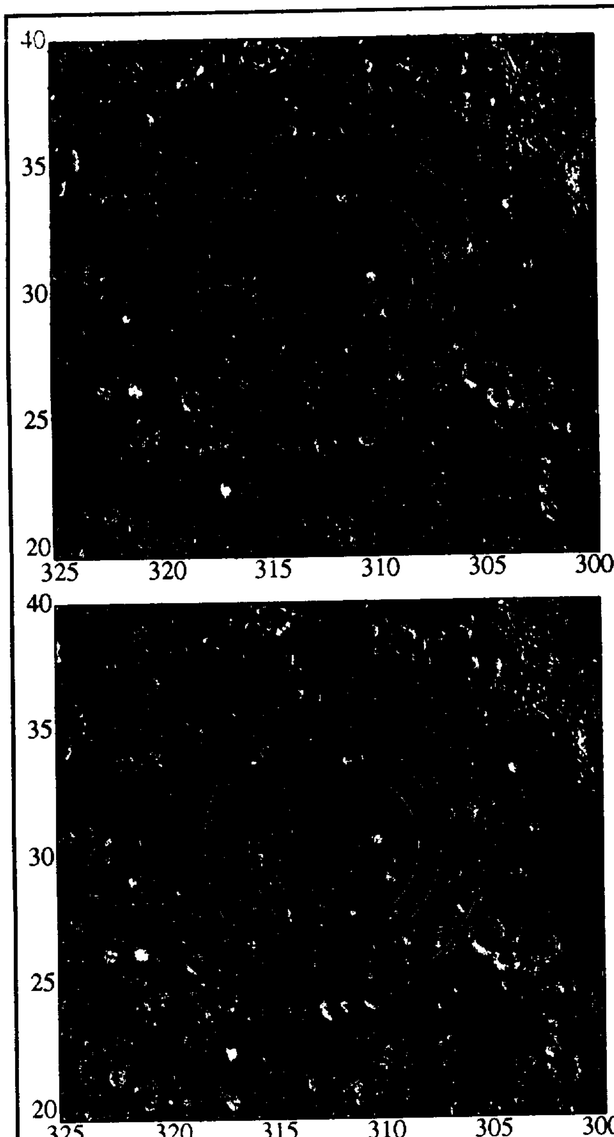

Figure 2. Elevation contours from USGS DEM (top) and a gridded data set that combines MOLA data from 30N and above with low resolution spherical harmonic representation of occultation-derived heights [10] (30N and south). The MOLA data in this grid has had cross-over adjustments to the orbits (Neumann, personal communication). Contour interval 0.5 km. Hatch marks indicate downhill direction. The MOLA Hole is the obvious closed depression in the lower panel. There is no hint of it in the USGS DEM. Also shown are the MOLA Hole basin center and rings based on concentric fits to the slope breaks in the two MOLA profiles (see Figure 3).

The topographic relief of the MOLA Hole is a puzzle. If the basin is a Cassini-like impact feature, it is surprising that whatever process removed or masked the original rim-like structure left the depression intact. Simple burial of the basin should have removed much of the elevation difference and certainly should have obscured interior slope breaks. We note again this basin is deeper than Cassini.

More "MOLA Holes" that have so far escaped detection may become obvious when the density of MOLA data becomes high enough. Finding one such previously unrecognized feature in the small percentage of cratered terrain so far sampled by MOLA suggest others should exist.

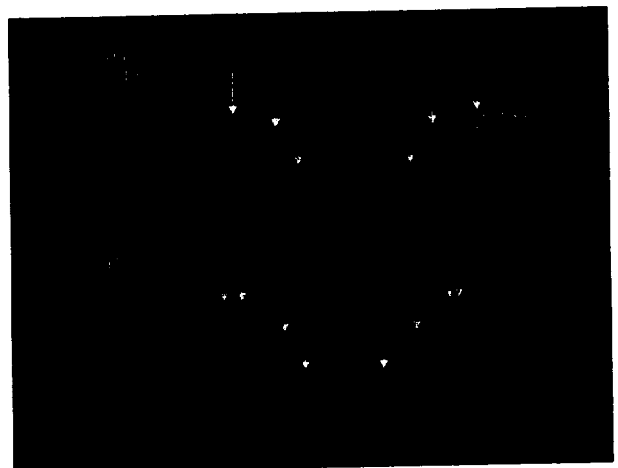

Figure 3: Details of passes 264 and 245 (Figure 1) with major slope breaks identified. Concentric fits to these were used to derive the basin center and (topographic) ring diameters shown in Figure 2.

References. [1] Wilhelms. D. E., JGR 78, 4048-4095, 1973. [2] Malin, M. C., Proc. Lunar. Planet. Sci. Conf. 7th, 3589-3602, 1976. [3] Wood, Ca. A. and J. H. Head, Proc. Lunar. Planet. Sci. Conf. 7th, 3629-3651., 1976. [4] Schultz, P. H. and H. Glicken, JGR 84, 8033-8047, 1979. [5] Schultz, P.H. et al., JGR 87, 9803-9820, 1982. [6] Stam, M. Lunar Planet. Sci. XVI, 813-814, 1985. [7] Pike, R. J. and P. D. Spudis, Earth, Moon, Planets 39, 129-194, 1987. [8] Schultz, R. A. and H. Frey, JGR 95, 14,175-14,189, 1990. [9] Frey, H. et al., GRL 25, 4409-4412, 1998. [10] Smith, D. E. and M. T. Zuber, Science 271, 184-188, 1996. [11] Frey, H. et al., submitted to JGR, 1999. [12] Frey, H. et al., Lunar Planet. Sci. XXIX, 1998.